Tri-Band Circularly Polarized Single Layer Patch Antenna for GPS Receivers

Aseim Elfrgani and C.J. Reddy
Altair Engineering, Inc. Troy, MI 48083
http://www.altairhyperworks.com/FEKO

A single layer planar circular polarized (CP) patch antenna is designed to operate at the current global positioning system (GPS) navigation bands, namely, GPS L1 (1575.42 MHz), GPS L2 (1227.6 MHz), and GPS L3 (1176.45 MHz), and also operates at lower frequency band of the European Galileo navigation system, namely, E5a (1164 MHz - 1189 MHz). The limited designated space on GPS receivers raises the need for low profile and easy to integrate antenna, which led us to choose a single layer patch antenna. Several techniques have been reported to design tri-band circular polarized antennas for GPS using patch antennas. Among these techniques can be classified as: 1) the use of stacked patch (O. P. Falade *et al*., IEEE Trans on Antennas and Prop, 60, 4479-4484, 2012) and others; 2) the use of array and quadruple antenna as in (Yijun *et al.* 2008 IEEE APS International Symposium) and (Yijun *et al.* IEEE Antennas and wireless Prop. lett., 5, 224-227, 2006); the use of slotted ground plane (G. B. Abdelsayed et al. 2010 10th Mediterranean Microwave Symposium 448-451). In this paper, we introduce an efficient way to design a single element single layer tri-band CP patch antenna with a regular ground plane using topology and shape optimization. Topology optimization is a mathematical approach that optimizes material layout within a given design space, for a given set of constraints such that the resulting layout meets a prescribed set of performance goals. The common way of carrying out topology optimization is through the material distribution approach, in which the design domain is divided into small elements, which together represent an image of the device. A design variable is assigned to each element to indicate presence or absence of a material.

In this paper, the patch is divided into hundreds of square cells. The shape of the patch is modified in order to obtain triple bands with minimal axial ratio keeping the physical volume of the antenna constant. The optimization steps are subsequently used to remove some of the metallic cells. For performance comparison benefits, both genetic algorithm (GA) and global response surface (GRSM) are used to obtain the required performance in a reasonable amount of time. Details of the design procedure and the simulation results of the proposed antenna will be presented and discussed at the symposium.